Residential neighborhood on Kelly Ridge. *Source: EDAW 2003*

Vegetation within study area on Kelly Ridge. *Source: EDAW 2003*

Figure 4.2-4a. Fuel load conditions in the study area.

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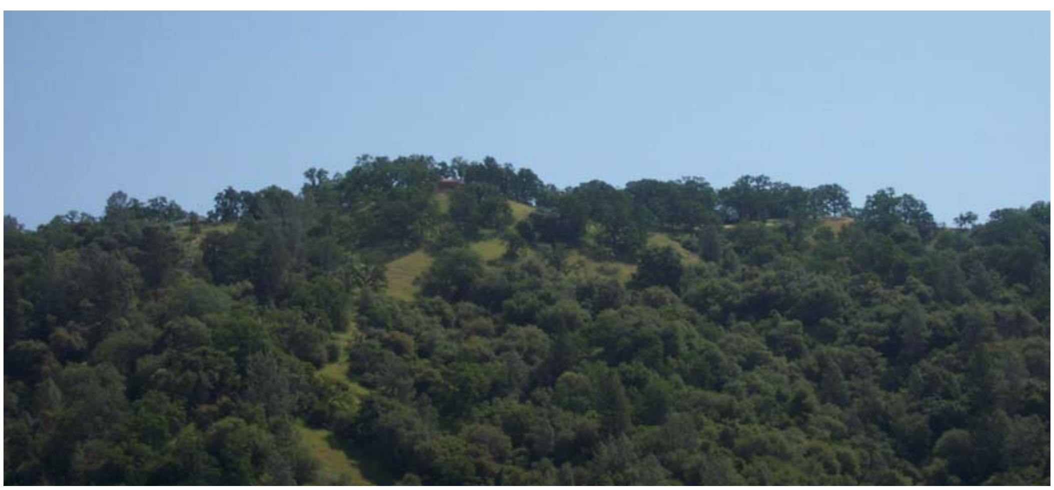
Canyon Creek area. *Source: EDAW 2003*



Foreman Creek area. *Source: EDAW 2003*

Figure 4.2-4b. Fuel load conditions in the study area.

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Upper South Fork area. *Source: EDAW 2003*

Upper South Fork area. *Source: EDAW 2003*

Figure 4.2-4c. Fuel load conditions in the study area.

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5.0 FUEL LOAD REDUCTION TECHNIQUES AND MANAGEMENT STRATEGIES

5.1 FUEL LOAD REDUCTION TECHNIQUES

Fuel load reduction techniques include methods to reduce the fuel load throughout a given area. Major methods include prescribed burning, pile burning, mastication, chipping and multicutting, disking and mowing, thinning, grazing, and herbicide application, treatments that are frequently used in combination. For example, ladder fuels may be thinned then pile burned as a pre-treatment to reduce understory fuels. In the future, the green may then be treated with a prescribed burn for ongoing maintenance. Table 5.1-1 provides a summary of each technique and further detail regarding effectiveness, use, and cost.

5.1.1 Prescribed Burning

A prescribed burn, also known as a controlled burn, is a fire ignited by management actions to meet specific objectives, such as removal of underbrush or exotic species (Figure 5.1-1). In forested areas, prescribed fires that are not lethal to dominant vegetation and do not substantially change the structure of the dominant vegetation are sometimes called an underburn. Approximately 80 percent of the aboveground vegetation is expected to survive an underburn fire. Using this technique, fire lines are constructed to contain the fire area, and the burn is targeted to remove shrubs and trees up to 6 inches diameter at breast height (dbh). Prescribed burns may also be used in grassland areas, especially to control weeds, reduce hazardous fuels, promote nutrient cycling and/or germination of native species, and improve wildlife habitat.

Prescribed burning must be used with great caution due to the risk of losing control of the fire. Planning and setting a prescribed fire can be very labor intensive and specific conditions have to be met for the fire to effectively and safely reduce fuels. Experienced personnel are required to be on site for fire management. Prescribed fires should only be set when conditions are safe; these conditions include low temperatures, low winds, and high humidity or moisture (CDF Website). Prescribed burning can be applied to most terrains. In wooded areas, prescribed fires are only recommended in mature forests with low ground vegetation and areas where fuels have not accumulated to create hazards of crown or high-intensity fires. Burning should only be applied to stands with a fire-resistant age composition. Smaller trees (less than 9 inches dbh) may be subject to mortality, and very large trees (greater than 18 inches dbh) may be subject to damage from the fire and subsequent growth may be slowed. Due to the potential of the fire to kill some individual trees and damage others, prescribed burning should be applied to stands with trees ranging from 9 to 18 inches dbh (Smith et al. 1997).

Prescribed burning may result in adverse impacts to air quality and wildlife. Wildlife species that are too slow to escape (some reptiles and amphibians) or that nest on the ground (small rodents and some birds) may be affected during the fire by direct mortality or after the fire by increased vulnerability to predators from the loss of shelter habitat. Predators, such as raptors, will benefit from the fire due to easier access to prey (University of Florida Cooperative Extension Service [UFLCES] Website). Animals

Table 5.1-1. Fuel load treatment technique comparison[1].

Method	Vegetation Type	Terrain	Advantages	Disadvantages	Relative Cost
Prescribed burn	Mature forest with low ground vegetation; prairies and grasslands.	All	Promotes germination, flowering, resprouting; deer browse habitat; pest and disease control; increased open space; effective for multi-tasking; can mimic natural regime.	Condition constrained; danger of losing control; requires experienced personnel; potential for slow growth or mortality of larger trees; wildlife mortality or increased predation; adverse impacts to air quality and smoke.	$60-400/acre
Pile burn	Woody shrubs and trees.	All	Nutrient recycling; promotes regeneration; easy to implement.	Labor-intensive; impenetrable soils from heat compaction; causes more hazard if not burned; rodent and bird mortality; follow-up treatment; land scars.	$25-2,000/acre
Mastication	Intermediate to mature forests.	Level to moderately sloped, non-rocky.	Least adverse effects on soils; nutrient recycling; efficient.	May require follow-up treatment; dangerous to workers; excessive downtime and ineffective if used on rocky sites	$500/acre
Chipping & multicutting (usually done by hand)	Brush, intermediate and mature forests.	Chipping: level to moderately sloped. Multicutting: steep slopes.	Nutrient recycling; chips left on site prevent erosion; alternative to burning; effective for multi-tasking.	Soil disturbance and erosion; requires roads; can spread weeds; damage to leave trees.	$575-1,600/acre
Disking & mowing	Grasses, forbs, brush, saplings.	Relatively flat, open areas.	Loosens compacted soil; nutrient recycling.	Topsoil disturbance; secondary treatment needed; encourages weed growth.	$10-30/acre
Thinning	Young- to intermediate-aged forests.	All	Increased growth of mature trees; park-like results; low risk.	Change species composition; requires roads; soil disturbance and erosion; must have a market for removed trees; labor-intensive; secondary treatment needed.	$230-850/acre
Grazing	Meadows and grasslands to moderately open forests.	Level, moderate, steep (<60% slope).+	Nutrient recycling; wide range of options for different objectives.	Management or herding is needed; requires fencing and water; political or social challenges; multiple treatments required; only effective with palatable plants; soil compaction.	$200-300/acre
Herbicides	Any	Any	Good for pre- and post - treatment of other methods; no soil disturbance.	Frequently requires secondary treatments; regulated; political and social challenges; impacts to water quality.	$2-50/acre

Source: Applegate Valley Website, CDF website

[1]Treatements are frequently used in combination. For example, an area may be thinned before a prescribed burn. Therefore, the cost of effectively treating an area should be calculated based on the combination of treatments.

Source: University of Wisconsin Steven's Point Fire Crew Website

Figure 5.1-1. Fuel load reduction technique: prescribed burning.

Source: Joel McNamara 1997

Figure 5.1-2. Fuel load reduction technique: pile burning

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that forage on young vegetative growth may also benefit from enhanced food availability after a fire.

Fire can be used in a manner that mimics natural processes. Prescribed burning is an ecological management tool that can reduce fire frequency and intensity, as well as promote native grass establishment, improve wildlife habitat, and improve the plant communities by age, class, and diversity (East Bay Municipal Utilities District [EBMUD] Website). Successful prescribed burns allow for less severe and less frequent subsequent fires through control of the fuel load.

Historically, natural fires burned the forests at a relatively regular frequency, creating fire-dependent communities and ecosystems. Through succession, forests recuperate from disturbances such as fire, which results in changes in the plant community. Burned stands tend to regenerate to the same tree species that were dominant before the fire. High-severity fires tend to favor the re-establishment of conifers with serotinous or semi-serotinous cones, in which the cones require fire to open and release seeds for regeneration. Low-severity fires tend to favor the re-establishment of hardwoods and woody shrubs that reproduce by suckering, sprouting, or seed banking (Luke et al. 2000).

The surge of vegetation that follows a disturbance such as fire can improve the browsing habitat for deer and increase the food supply for some wildlife species by increasing the availability of succulent vegetation, nuts, and fruits. Pest control is accomplished through burning, which reduces the incidence of foliage diseases, insect infestations, fungal growth, and other pests. Fire improves access within the forest by increasing openings for wildlife, natural regeneration of vegetation, and recreation visibility (UFLCES Website).

Controlled burns are relatively economical, costing from $60 to $400 per acre, depending on location, topography, conditions, and the need for adjacent land protection (Applegate Valley Website). Prescribed burning may be the most cost-effective fuel treatment for an area, especially those managed for ecosystem sustainability and restoration of natural processes where mechanical methods are not suitable (e.g., National Parks) (Omi et al. 1999). There are, however, potential negative effects on air quality and risk of loss and liability if the fire gets out of control and moves to adjacent properties, resulting in property damage (CDF Website). Regardless, numerous studies with the U.S. Fish and Wildlife Service (USFWS), USFS, and BLM have shown that the per acre cost of suppressing fires is four to ten times the cost of a planned, prescribed fire (Omi et al. 1997).

5.1.2 Pile Burning

Pile burning is a method in which material is cleared and placed into piles either by hand or mechanically, and then burned (Figure 5.1-2). This method is used on most terrains for shrubs and small trees (usually 6 inches dbh or less, sometimes up to 12 inches dbh). Pile burning reduces the concentration of surface and ladder fuels. In addition, nutrients are recycled into the soil by pile burning because the fuels remain on site, are broken down, and remain part of the ecosystem.

Pile burning is a labor-intensive option and usually requires a follow-up treatment; however, mechanical equipment can be used (Smith et al. 1997). Hand removal is expensive and provides little additional benefit compared to mechanical removal, except when working in sensitive areas. Pile burning returns nutrients to the soil and exposes mineral soils, which promotes regeneration of grasses and shrubs; however, the intense heat from a fire consolidated in one place can result in black scars on the land and severely compacted soils. The soils may become impenetrable to water for many years, adversely affecting water uptake of surrounding vegetation and reducing the germination of seeds (CDF Website; Smith et al.1997).

Piling materials in advance of burning can increase fire hazards if they are not burned immediately and are left on the forest floor due to a delay of funding or because of unsuitable weather conditions. The piles may become untreated high-risk fuels. In addition, some wildlife species, such as rodents and birds, will nest or den in large slash piles for protection. Protection of resident wildlife, especially special-status species, can cause management challenges when the conditions allow for the piles to be burned (Fox and Ingalsbee 1998; Smith et al.1997).

Pile burning can cost from $25 to $2,000 per acre, depending on the method of removal. Hand removal is more labor-intensive and therefore more expensive (Applegate Valley Website). Pile burning can be a less-expensive alternative to broadcast or prescribed burning but may result in soil compaction. Small fires that are fed the piled material (instead of igniting the entire pile) may create less intense fires and prevent overheating of the site (University of California, Forest Products Laboratory [UCFPL] Website).

5.1.3 Mastication

Mastication is a mechanical method of fuel load reduction which involves a bulldozer or tractor with a special attachment called a “cutting head” (Figure 5.1-3). The cutting head is placed over trees or shrubs, grinds them into mulch, and presses the mulch into the ground. The masticator can clear brush, shrubs, and small trees up to 10 inches dbh. Mastication can be used to achieve crown separation and desired canopy cover levels on moderately sloped (<40%), non-rocky terrains.

Mechanical methods that involve large machinery and roads, such as mastication, generally result in ground disturbance, soil compaction, and soil erosion. Mastication is costly compared to other mechanical methods, requires specialized equipment, and may require a follow-up treatment such as a herbicide application or prescribed burn (CDF Website). In addition, the technique has limitations on rocky sites. If the cutting head is used at ground level, it may dislodge rocks, which can endanger workers. The rocks may also damage the cutting head and delay the project. Alternatively, if the cutting head is kept above the rocks, plants will not be cut close to the ground surface, and the desired result may not be achieved (USFS Website).

Source: California Forest Stewardship Program Website

Figure 5.1-3. Fuel load reduction technique: masticator.

Figure 5.1-4. Fuel load reduction technique: pre-thinning (left) and post-thinning (right) treatment

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Of the available mechanical methods (e.g., thinning, chipping), mastication has the least adverse effect on soils. This method allows for the fuel to remain on site as mulch, a less hazardous form. The benefit is that the mulch is left on site and the nutrients are recycled into the ecosystem. The mulch also reduces germination of brush species.

Mastication costs approximately $500 per acre, which is expensive compared to other mechanical options; however, it is very efficient and has the least adverse effects on soil compared to other mechanical methods (CDF Website). This method is best used in densely vegetated, non-rocky areas where a prescribed fire is not suitable.

5.1.4 Thinning

Thinning is a method used to remove biomass from a stand to achieve crown separation and desired canopy cover levels (Figure 5.1-4). Trees are removed to reduce competition among target species for sunlight, water, and soil nutrients. Often trees are thinned to have a spacing of between 16 and 22 feet. Trees to be thinned are usually 6 inches dbh or less, occasionally up to 12 inches dbh. Thinning of trees or excess brush may be done by hand or mechanically. Thinning from below is a process that begins with removal of smaller trees but includes removal of trees up to 30 inches dbh. Thinning can be used in dense, multi-aged forests and on most terrains, depending on how the trees are removed from the site.

Generally, the result of thinning is increased growth in diameter and height of the remaining trees. The amount of growth that results from thinning varies by the tree species, age, and condition. Generally, younger trees respond more to thinning compared to older and more established trees. Shade-intolerant species also respond more readily to thinning due to the increase in light available. The species composition of a stand may be changed after thinning, depending on the vegetation that is removed (CDF Website). If the vegetative material from thinning operations is not picked up or burned, then it may add to the ground fuel and worsen fuel load conditions.

Like other mechanical treatments, thinning requires a road system for equipment access, which may cause soil disturbance and soil erosion in wet conditions. Thinning also increases the stands exposure to sunlight, which may reduce moisture levels, increase temperatures, and result in a higher potential for wildfire ignitions. Thinning of large-sized trees is often done for commercial purposes and is generally focused in high value timber areas, leaving the low value areas in danger of fire with hazardous fuel loads (Fox and Ingalsbee 1998). The sale of timber could alleviate the costs of the fuel load removal, although thinning for fuel load management generally yields smaller diameter trees, which are difficult to market. If the timber is not sold to a commercial market, it may remain on the forest floor due to lack of funds to remove it. This would thereby increase, rather than reduce, the fuel load.

Thinning is a low-risk method compared to prescribed fire. It results in more open forests with less understory growth and allows for increased growth of canopy trees. However, it is disruptive to the site, requires a secondary treatment, and is moderately expensive ($230-850 per acre) (Applegate Valley Website). The cost-effectiveness of thinning is low compared to other mechanical methods and requires a local market for smaller trees (Fox and Ingalsbee 1998).

5.1.5 Chipping and Multicutting

Chipping and multicutting is similar in concept to thinning, only the cut material is left in place rather than removed from the site. Chipping involves grinding shrubs and small trees into small pieces, which can then be used as mulch or ground cover (Figure 5.1-5). Multicutting is similar, except that shrubby material is chopped into smaller pieces by hand and left in place as mulch; therefore, it is particularly useful on steep hillsides.

Chipping involves large machinery, such as bulldozers to fell trees and chippers to crush the vegetation. Chipping can be used in intermediate to mature forests and on level to moderately sloped terrain (Applegate Valley Website). Chipping is usually done along roads, and the chips are used as road cover to prevent erosion. This allows the nutrients to be left on site and is efficient for accomplishing multiple tasks at once.

Multicutting is more labor-intensive than chipping. Material is manually cut into lengths no longer than 6 inches. Ideally, the cut material is left 3 inches deep and acts as mulch by absorbing rain and precluding sunlight from regenerating fuels and exotic plants. Multicutting works well on steeper slopes and areas not easily accessed by machinery (CDF Website; UCFPL Website).

Chipping requires roads and machinery access, resulting in soil erosion and disturbance. This method is also prone to spreading weeds and can damage remaining trees. Chipping and/or multicutting are often used when burning is not feasible due to constraints in conditions or lack of experienced personnel (Smith et al.1997). Due to the high level of manual labor, the cost of these techniques is high ($575 to $1,600 per acre) (Applegate Valley Website).

5.1.6 Disking and Mowing

Disking and mowing are fast methods to clear areas and reduce fuel biomass while returning nutrients to the soil. Disking is a rapid and economical way to loosen compacted soils while removing vegetation (Figure 5.1-6); it is the most widely used mechanical method (UCFPL Website). Plants of sapling size (<0.5 inch dbh) and smaller are broken down and folded into the soil. Mowing removes the top portion of the vegetation but leaves the roots intact. Both of these methods work best on grass and low, shrubby vegetation in relatively flat, open terrain.

As previously mentioned, disking and mowing involve mechanical equipment, which cause disturbances to the land, including soil erosion and compaction. Although these methods can cover large areas fairly quickly, large mechanical equipment is regarded as more potentially damaging than fire, herbicides, or other tools (UCFPL Website; Smith et al. 1997). Disking disturbs topsoil and encourages weed growth, so a secondary treatment is usually needed. Secondary treatments can be accomplished with another disking, burning, or herbicide application.

Source: Friends of Leckhampton Hill & Charlton Kings Common Website

Figure 5.1-5. Fuel load reduction technique: chipping.

Source: Swainsboro Forestry Technology Program Website

Figure 5.1-6. Fuel load reduction technique: disking.

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Mowing is an effective treatment, but it is limited to use only on flat, open areas with slopes of less than 30 percent (CDF Website). It is recommended for picnic and recreation areas, trailheads, and along trails. Mowing requires annual upkeep and leaves a distinct, unsightly edge between areas mowed and not mowed (UCFPL Website). The size of vegetative material that a mower can handle generally includes grasses, forbs, and possibly small seedlings or very young saplings (< 0.5 inch diameter). Mowing spreads seed and encourages new growth and sprouting. Follow-up treatments would be needed to keep fuel loads at a safe level.

Mowing and disking are both relatively inexpensive ($10-30/acre), depending on the labor costs and machinery used (University of Florida [UFL] Website). Disking is more effective than mowing at stopping the spread of fire because it breaks the horizontal continuity of the vegetation, whereas mowing simply reduces the plant height (EBMUD Website). However, disking has more adverse impacts to soil and ground-burrowing wildlife compared to mowing. Both methods can only be applied to open, flat areas and are similarly cost-effective.

5.1.7 Grazing

Grazing animals, such as goats, horses, or cows, can be used to remove vegetation in meadows, grasslands, and open forest areas (Figure 5.1-7). Grazing is less effective on steep terrain (>60 percent slope) and woodlands in excess of 50 percent cover. Several options are available, depending on the management goals and limitations of the site. Horses and cows typically graze on grasses, not shrubby materials, but goats will consume shrubs and thorny plants. Goats are particularly effective at removing vegetation from steeper slopes. Often, animals are kept in an area by a temporary fence, such as a portable electrified fence, and moved accordingly.

By leasing land to ranchers, grazing can be a revenue-generating option (EBMUD Website). Grazing is considered a natural way of managing fuel load levels; it returns nutrients to the soil through animal waste and can reduce fuel load significantly. However, grazing animals eat all types of vegetation, including desirable plants. . Carefully managed grazing programs can restore degraded ecosystems to historical conditions. For example, it has been used to convert non-native annual grasslands to perennial bunchgrass communities [New Mexico Environment Department (NMED) Website].

Goats can be used to graze small, confined areas and steeper slopes. Compared to cattle, their range of palatable vegetation is wide, including grasses, forbs, brush, and trees. Unfortunately goats will also strip the landscape and cause erosion if left alone without a herder [California Air Resources Board (CARB) Website]. Livestock, such as cattle and horses, can be less management-intensive than goats and they can be used on grassland sites with up to 35 percent slope. Cattle have a limited range of palatable vegetation, preferring grasses and forbs. Cattle can be used on large free-range lands, although they require management to keep them from eating and trampling valued woody plants (CDF Website). Horses prefer grasses and will not eat shrubs or woody plants; therefore, they cannot clear a site but are effective at maintaining grassland (CDF Website, UCFPL Website).

Grazing can damage sensitive habitats and is not best suited for urban interface areas due to noise, odors, and the dust they create, which is incompatible with nearby residences. Excessive use by grazing animals can also lead to soil compaction and erosion. Animal waste may return nutrients to the soil, but may also contaminate water sources. Permanent or temporary fencing and water access are needed to contain the grazing animals, which can be a costly and time-consuming option. In addition, herd management is needed to prevent livestock from denuding the land. Other disadvantages include the need for multiple treatments when used as a primary vegetation removal technique, and no effect on species that are not palatable to the grazing animals (CARB Website).

Grazing can cost up to $200 to $300 per acre, depending on revenue made from ranchers and the availability of water and fencing (Applegate Valley Website). Grazing also requires 5 or more acres of land, and on-site management to prevent damage to the land. However, grazing provides options and can be a cost-effective method of fuel load management on meadow and grassland areas.

5.1.8 Herbicide Application

Herbicides are chemicals designed to kill or inhibit plant germination. These chemicals are designed to target specific species, or can be general mixes for broad application. Herbicides may be injected into stems, applied to the surface of freshly cut stumps, placed in a continuous ring around the basal bark of a tree, applied directly to soil to be taken up by plant roots, or applied to foliage (Figure 5.1-8). Herbicides can be used on any vegetation type or terrain.

Plants respond in varying ways to herbicides, depending on a species' susceptibility and environmental conditions. They do not remove vegetation, but are generally used as a pre- or post-treatment. Using herbicides prior to burning (brown and burn) allows for a more efficient burn, reduces smoldering, and assists with smoke management (CARB Website). Herbicides can also be used post-logging or post-burning to control the abundance of vegetative growth that follows the disturbance (CARB Website). However, if used as a primary method for broadcast removal of all vegetation, herbicide-resistant weeds can take over the site (UCFPL Website).

Herbicide removal of vegetation does not affect forest floor conditions, unlike most mechanical methods (Smith et al. 1997), although the chemicals, associated labor, and equipment needed for their application can be expensive, when compared to other methods.

Certain regulations apply to the use of herbicides for protection of the applicator and the environment, including water quality. Public controversy over the risk of herbicides to human health, bioaccumulation, and lethal effects to adjacent plants can deter the use of herbicides if the treated area is near urban areas (NMED Website). Although studies

Source: Queensland Department of Forestry Website

Figure 5.1-7. Fuel load reduction technique: grazing.

Source: USFS Southern Research Station Website

Figure 5.1-8. Fuel load reduction technique: herbicides

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have shown that herbicides used in forestry practices are non-toxic to wildlife, do not bio-accumulate, and are eliminated quickly, wildlife may be indirectly affected through habitat modification (McNabb 1997).

Herbicides are often used in combination with other techniques, either prior to or following another treatment, such as burning or disking. When used alone for fuel load management, herbicides frequently require secondary treatments. The cost of herbicides varies greatly ($2 to $50), depending on the type of vegetation treated, the kind of herbicide used, and the application method (Taylor and Koo 2001).

5.2 LANDSCAPE LEVEL FUEL LOAD MANAGEMENT STRATEGIES

Fuel load management strategies refer to methods for prioritizing or locating fuel treatments on a landscape scale to increase their overall effectiveness for reducing the extent of severe wildfires. Most past fuel management in the Sierra Nevada has not involved strategic planning, but has been a response to removal of fuels after a timber sale or other specific activity. With the recent move toward ecosystem management, fire managers and foresters have begun to address forest health concerns, including fuel management at a landscape level (Weatherspoon and Skinner 1996).

Three general approaches have been used (Weatherspoon and Skinner 1996):

- Identifying fuel-management approaches appropriate within each of several landscape zones defined by general characteristics, uses, or emphases;
- Setting priorities based on various combinations of risk, hazard, values at risk, and suppression capabilities; and
- Employing a fuelbreak-type concept intended to interrupt fuel continuity on the landscape scale and to limit the size of fires by providing defensible zones for suppression forces.

5.2.1 Strategies Based on Zones

This strategy for landscape-level fuel load reduction proposes three landscape zones. Zone I includes wilderness and natural areas; fire management in this area would emphasize natural fire, augmented by management-ignited prescribed fire to restore the natural role of fire to the ecosystem. In Zone II, the general forest management zone, fuel management would be planned and implemented in conjunction with proper timber harvests. In Zone III, the residential forest, homeowners and local officials would be educated about the realities of fire hazards in the wildland-urban interface, and aesthetically pleasing manipulations of fuel loads would be established, such as shaded fuelbreaks (see definition in Section 5.2.3). Other variations of this strategy create zones based on structure, density, or the degree of modification to the natural processes (Weatherspoon and Skinner 1996).

5.2.2 Strategies Based on Risk, Hazard, Values at Risk, and Suppression Capabilities

Decision analysis has been used by some to aid in fuel-management decisions. This analysis involves using topography, historical weather, historical fire occurrence (risk), suppression capability, and fuel hazard to determine probabilities of various fires by intensity class. This information is intended to provide a consistent means of evaluating the important factors affecting fuel-treatment decisions. In addition, sometimes acceptable resource loss will determine treatment options. Some of these strategies assign a point system to calculate catastrophic fire vulnerability ratings based on qualitative assessments of risk, hazard, value, and suppression capability (Weatherspoon and Skinner 1996).

5.2.3 Strategies Based on Fuelbreaks

A fuelbreak is defined as a wide (generally 60 to 1,000 feet) strip of land in which native vegetation has been permanently modified so that fires burning into it can be more readily controlled (McPherson et al. 1990 *in* Weatherspoon and Skinner 1996).

The term “shaded fuelbreak” is also used to describe a method of fuel removal that limits the regrowth of vegetation by shading the understory, reducing the likelihood of a crown fire. Shaded fuelbreaks typically leave some larger trees within a given area, but are not necessarily designed to provide fire fighters a safe space from which they can fight the fire. The creation of shaded fuelbreaks in narrow strips (200 to 400 feet) is considered by some to be too narrow to effectively stop a fire under many conditions; other strategies discussed below suggest a width of 1/4 mile (Weatherspoon and Skinner 1996). A shaded fuelbreak is also usually considered to be a stand-alone treatment for a specific area, rather than a strategy applied over a larger landscape.

There are many ways that fuelbreaks can be arranged on the landscape. The Quincy Library Group, a community-based group representing a wide range of interests, has suggested a network of defensible fuelbreaks [Quincy Library Group (QLG) 1994]. In 1995, the Lassen National Forest, Plumas National Forest, and Sierraville Ranger District of the Tahoe National Forest published a Technical Fuels Report, which describes fuel reduction strategies based on Defensible Fuel Profile Zones (DFPZs), Community Defense Zones (CDZs), and Fuel Reduction Zones (FRZs) (Olson et al. 1995 in Weatherspoon and Skinner 1996). Other landscape treatments used by the USFS include Strategically Placed Area Treatments (SPLATs) and group selection (USFS 2002). Each of these strategies is described below. They all involve use of mechanized, ground-based felling, skidding, and piling equipment on slopes less than 35 percent. On slopes greater than 35 percent, helicopter equipment is generally used.

5.2.3.1 Defensible Fuel Profile Zones (DFPZ), Community Defense Zones (CDZ), and Fuel Reduction Zones (FRZ)

DFPZs consist of a network of corridors along roads and ridges that inhibit fire-spread and provide a defensible area for fire suppression. The width of the fuelbreak is generally 1/4 mile but may vary based on expected suppression strategies, topography, and other site-specific conditions. DFPZ creation involves thinning surface fuels and ladder fuels; it may also include thinning the canopy to achieve desired canopy separation. DFPZs are not designed to stop an oncoming fire by themselves, but rather to provide a safe location to facilitate fire suppression efforts and provide an anchor point for prescribed burning projects (USFS 2001). DFPZs are intended to be installed over a period of just a few years and provide a framework for the landscape treatment. They are not intended to replace other fuel treatments; rather, they are intended to increase the effectiveness of initial treatments and to facilitate subsequent treatment of adjacent areas (Weatherspoon and Skinner 1996).

Another component of this strategy is the creation of CDZs in urban interface areas within or near National Forest boundaries. Similar in concept to a DFPZ, a CDZ is designed to reduce the threat of wildfire spreading onto National Forest land from private land, or vice versa. The involvement and cooperation of local communities is essential to the successful implementation of CDZs (Weatherspoon and Skinner 1996).

A third type of zone, the FRZ, refers to a general area of fuel treatment that would take place mainly after DFPZs and CDZs are in place, because those systems have higher priority for protecting the landscape at large and the urban interface. FRZs would be created within areas of the forest that need treatment, and would not provide a linear defense system like DFPZs, or specifically protect surrounding communities likes CDZs. However, the objectives of FRZ creation are similar to DFPZs and CDZs in that surface and ladder fuels are reduced and canopy separation is created to provide a broad area where a fire could be effectively and safely be suppressed (Weatherspoon and Skinner 1996).

5.2.3.2 Strategically Placed Area Treatments (SPLATs)

SPLATs, or area fuel treatments, are areas where fuels are reduced to inhibit fire spread. Rather than strips of land like DFPZs, SPLATs are strategically placed blocks of land, ranging from 50 to over 1,000 acres. In order to reduce continuous areas of hazardous fuel load conditions, the treatment areas are placed to inhibit a fire from spreading from the bottom of the slope to the ridge top. SPLAT creation includes thinning surface and ladder fuels and reducing canopy cover, if needed. Managers consider historic fire regimes and the potential for severe fires (based on fuel load, prevailing wind direction, and terrain features) in deciding where to place area treatments (USFS 2001).

5.2.3.3 Group Selection

Group selection is a system used by foresters to create uneven-aged stands. Group selection is intended to create and maintain a sustainable, small patch mosaic of all-age, multi-story forest structures, to provide a source of forest products, and to improve, over time, the forest’s resistance to fire. In the treatment regimes proposed by the Lassen and Plumas National Forests, an average rotation age of 175 years would be targeted. Specific group selection treatments would create ½- to 2-acre groups. Over the long term, the result would be 9 to 18 groups of similar-aged vegetation (i.e., cohorts), depending on the selection treatment regime, across the landscape over the next 175 years. However, the group selection treatment is also designed to preserve and promote future development of older components of the forest by using an upper-diameter limit to retain existing trees that are larger than would be expected to grow in 175 years (USFS 2002). Group selection is typically used on very large areas (thousands of acres), but the size of the groups depends on the objectives.

5.2.4 General Discussion and Evaluation of Fuelbreaks

Limited information is available on the new concepts for fuelbreaks due to the continued discussion of how to use fuelbreaks in landscape-level fire control. Therefore, the majority of the information provided in the section is derived from *Landscape-level Strategies For Forest Fuel Management* (Weatherspoon and Skinner 1996).

Fuelbreaks are typically located along ridge tops. A strip of land is cleared of fuel either mechanically or manually to create a retarding area that would slow or stop wildfires and provide a place for firefighters to defend and protect from the fire spreading. The effectiveness of fuelbreaks was documented by wildfire incidents in the 1960s and 1970s and was generally effective in stopping wildfires, except under extreme conditions. To be successful, fuelbreaks must be properly installed, properly maintained, and adequately staffed by suppression forces (Weatherspoon and Skinner 1996).

Fuelbreaks in general have not been used in the Sierra Nevada over the past 20 years for several reasons: fuelbreaks must be staffed with suppression forces in order to be effective, previous recommended widths were too narrow to be successful, competition with other area-wide treatments, and lack of focus on benefits to other resources besides fire control (Weatherspoon and Skinner 1996). They are also mostly ineffective in extreme fire behavior [California Fire Resource Assessment Program (FRAP) Website]. Spatial placement and frequency of maintenance largely affect the success of fuelbreaks. Fuelbreaks are not an alternative to strategic fuel treatment, but are most effective when accompanied by strategic fuel management. When designed as part of a community plan, fuelbreaks can be efficient and cost-effective in protecting homes and other structures from wildfire (Graham and McCaffrey 2003).

Fuelbreaks have been revisited as a potential fire control method over the last 10 years due to several large severe fires in California, the protection requirements for spotted owls, and the establishment of the Quincy Library Group (QLG). The original concept of fuelbreaks is being modified and improved to alleviate the previous disadvantages to the extent possible. A linear programming model predicted that increasing the width of a fuelbreak reduced the area affected by a fire. The QLG proposed an intensive program to install a network of fuelbreaks approximately ¼ mile wide and along most roads to break up fuel continuity (Weatherspoon and Skinner 1996).

The fuelbreak concept, with input from the QLG proposal, has evolved into various types of fuel protection zones, including DFPZs, CDZs, and FRZs. Benefits of DFPZs include reducing the severity of wildfires within treated areas, providing broad zones within which firefighters can conduct suppression operation more safely and efficiently, effectively breaking up the continuity of hazardous fuels across a landscape, and providing anchor lines to facilitate subsequent area-wide fuel treatments (Weatherspoon and Skinner 1996).

DFPZs have not been widely implemented so limited information is available on their effectiveness. However, they are expected to be safer for fire suppression personnel due to the low fuel levels, less snags, and more resistance to crown fires. It is anticipated that DFPZs will also improve the efficiency and productivity of suppression forces by providing a higher potential to build and hold a fire line and more open canopy for aerial retardant drops to be more effective (Weatherspoon and Skinner 1996). Fuelbreaks are used as indirect attack lines for controlling fires that are set as a method of reducing the spread of a wildfire (e.g., back fires). They also form good boundaries for fuel management units (FRAP Website).

Other benefits anticipated from the use of DFPZs include: open conditions similar to presettlement forests, reduction in evapotranspiration leading to increased water yield, less water quality impacts due to greater distance from streams, overall habitat diversity, aesthetic variety, timber stand improvement, and possibly slower movement of insect infestations (Weatherspoon and Skinner 1996).

The long-term effects, length of effectiveness, and frequency of maintenance for strategic fuel treatments combined with landscape level fire management are not fully understood. However, it is evident that these techniques can effectively disrupt fire growth and change fire behavior (Graham and McCaffrey 2003). The largest drawbacks to DFPZs are the economic viability of smaller trees being removed and the maintenance of the treated areas. Essentially, these are challenges related to any fuel load management technique or strategy; however, it is important that they be resolved. DFPZs are expected to be less costly to maintain due to the relative continuity and accessibility. Fuelbreak construction can increase timber value by reallocating resources to larger, faster-growing, and more valuable trees. Therefore, the cost of implementing and maintaining fuelbreaks would be offset by the increase in timber value (Weatherspoon and Skinner 1996).

5.3 Overall Summary of Effectiveness of Fuel Load Management

Many researchers and professionals have concluded that, overall, pretreatment and fuel load management reduce the intensity and severity of wildfires as well as reduce impacts to valued resources. Benefits of fuel treatments are assessed by examining subsequent fire behavior, physical effects on resources, economic losses, enhanced forest health, and increased firefighter safety (FRAP Website).

Numerous field accounts yield evidence that fires were reduced in severity when they burned into areas previously burned or treated (Agee et al. 2000, FRAP Website). The CDF has compiled 26 reports documenting the benefits of the Vegetation Management Program (VMP) associated with reduced fire size and increased resource protection during wildfire events (FRAP Website). In the case of the 2002 Haymen fire in Colorado, several areas that had fuel treatments illustrated the relationship between surface, ladder, and crown fuels. An area treated with a prescribed burn the previous year and an area mechanically thinned were both successful at stopping or reducing the fire when it came through. However, a third site where smaller trees were removed from the canopy and left on site experienced 100 percent mortality due to the large amount of surface fuels (Graham and McCaffrey 2003).

Fuel treatments that remove ladder fuels reduce the potential for crown fires, which are difficult to control and typically devastating. According to Omi et al. (2002), crown bulk density is not the most strongly correlated variable to fire severity; height to live ratio crown is the determining factor for crown fire initiation. Therefore, treatments that reduce crown density (e.g., thinning) would be ineffective without accompanying treatments for surface and ladder fuels (Agee et al. 2000).

There is a direct correlation between the severity of a fire and the fire's impacts to wildlife (FRAP Website). Most researchers feel that fire-related wildlife mortality is minimal, but the fire's impact on habitat, which affects food, cover, and microclimate, has more significant effects on wildlife. Some species of wildlife that are dependant on dense forest habitat may have to relocate after a fire; however, other species may move in after the fire if they prefer recently disturbed or open habitats. Most species of mammals and breeding birds will remain in an area after a fire (Kilgore 1976).

Fuel load management has benefits in addition to fire control. Reduced damage and loss of timber resources are evident from areas treated for fuel load. A study conducted in 1979 found mortality of 100 percent in untreated stands compared to 17 percent for treated stands. Firefighter safety is increased with fuel management due to the removal of excess fuel and ladder fuels, which are components to high hazard fires. Prescribed burns used as fuel treatments also provide good training opportunities for firefighters without the impending need for suppression (FRAP Website).

Areas with natural fire cycles of short interval and low-intensity fires are likely to have significant ecosystem benefits from fuel treatments conducted by prescribed burning to emulate natural fire effects. Without natural fires, the natural succession of the forest produces higher stocking of vegetation and shifts in structure. This environment decreases biodiversity and increases vegetation mortality from competition, insects, and pathogens. Returning fire to the ecosystem as a restoration practice and fuel load treatment can reverse this trend.

It is difficult to evaluate the cost-effectiveness or financial benefits to using fuel load management treatments due to poor data or speculation of costs and losses. However, several models have been developed that can predict the costs and losses of wildfires using expert knowledge and varying inputs for conditions such as topography, weather, fuel load, wind speeds, etc. A study conducted in 1991 found that prescribed burning reduced costs and losses by 26 percent. According to Omi et al. (1997), the costs of USFS suppression forces from 1985 to 1993 were four times higher than planned prescribed fires ($18.4 vs. $4.27 million), excluding Alaska. In each USFS region, the cost per acre of suppression was 10-60 times the cost of an average prescribed fire.

6.0 FUEL LOAD MANAGEMENT POLICIES AND PLANS

The primary fire management programs in and immediately surrounding the study area are managed by the USFS, CDF, and DPR. BLM, DFG, Butte County, and the City of Oroville also have lands within the vicinity with policies on fire management or suppression. Table 6.0-1 lists the policies and plans that have been reviewed for L-5.

Table 6.0-1. Relevant fire management policies and plans in the study area.

Agency	Document Title	Date
FEDERAL		
Department of Agriculture	Healthy Forest Initiative	2002
USFS	Sierra Nevada Forest Plan Amendment, Record of Decision (ROD)	2001
USFS	Plumas and Lassen National Forests, Proposed Administrative Study	2002
BLM	Redding Resource Management Plan	1993
STATE		
CDF & State Board of Forestry (SBF)	The California Fire Plan	1996
CDF	Butte Unit Fire Management Plan	2002
DPR	Wildfire Management Planning: Guidelines and Policy	2002
DPR	Loafer Creek Prescribed Fire Management Plan.	1999
DFG	Oroville Wildlife Area Management Plan	1978
LOCAL		
City of Oroville	General Plan	1995
Butte County	General Plan	1996

Source: Compiled by EDAW 2003

6.1 HEALTHY FOREST INITIATIVE, 2002 (DEPARTMENT OF AGRICULTURE)

In December 2002, the Bush Administration announced a series of steps to reduce the threat of catastrophic wildfires and improve the health of the forests. The Healthy Forests Initiative will implement core components of the National Fire Plan's 10-year Comprehensive Strategy and Implementation Plan. The National Fire Plan, which was adopted in 2000 by Federal agencies and western governors in collaboration with county commissioners, State foresters, and tribal officials, calls for more active forest and rangeland management. It establishes a framework for protecting communities and the environment through local collaboration on thinning, planned burns, and forest restoration projects. The intent of the initiative is to streamline the process for approving projects to reduce the threat of wildfires and insect infestations. The new procedures are intended to ensure that environmental and public reviews are conducted in the most efficient and effective way possible.

6.2 PLUMAS AND LASSEN NATIONAL FORESTS PROPOSED ADMINISTRATIVE STUDY, 2002 (USFS)

The USFS manual states that “the objective of fire suppression is to safely suppress wildfires at a minimum cost consistent with land and resource management objectives and fire management direction as stated in fire management action plans” (USFS 1994). USFS lands in the study area are part of the Plumas and Lassen National Forests and are managed under the *Plumas National Forest Land and Resource Management Plan* (USFS 1988). This plan establishes a suppression-only policy for wildfire management. In addition, management of these lands is influenced by the more recent *Sierra Nevada Forest Plan Amendment* (SNFPA) (USFS 2001), which was developed largely to improve forest management to include conservation strategies for old-growth forest and associated species (such as the California spotted owl).

The SNFPA directed that a proposed study be carried out to address significant scientific uncertainties that are confounding management decisions. As a result, the Plumas and Lassen National Forests are proposing to conduct an administrative study on fire and fuels management, landscape dynamics, and fish and wildlife resources (USFS 2002). The study is needed to resolve persistent questions about the effects of vegetation management actions on wildland fire behavior, silvicultural goals, landscape dynamics, and viability of species dependent on old forests. The purpose of the study is to gather scientific data to resolve key ecological and forest management questions to make informed future management decisions.

An administrative study was proposed in December 2002 but was cancelled on April 25, 2003 because of the need to configure a different study proposal that accommodates the implementation of the mandating legislation (Herger-Feinstein Quincy Library Group Forest Recovery Act) and the National Fire Plan while simultaneously addressing concerns with the scientific design of the originally proposed study. However, the cancelled study design is presented below as a guide to understanding some of the potential treatment options.

The proposed study area included western portions of the Plumas and Lassen National Forests. The area included approximately 1.13 million acres, divided into 11 treatment units based on watersheds. Each treatment unit was assigned one of three treatment regimes (Table 6.2-1). The replication of treatment regimes was designed to allow statistically valid analysis of the relative resource response to the type of forest management, but was found to be inadequate.

Although the proposed administrative study would have covered a large portion of the land within the Plumas and Lassen National Forests, other National Forest lands may be managed for fuel load reduction. Primary techniques that the Plumas National Forest use are thinning-from-below, mastication, and underburning; in some areas, goats may be also be used. However, no fuel load reduction activities are planned in the study area due to the steepness and inaccessibility of the terrain (pers. comm., Case, 2003).

Table 6.2-1. Treatment regimes established in the Plumas and Lassen proposed administrative study.

Treatment regime	DFPZs	Group Selection	SPLATs
A	Treatment to comply with SNFPA direction.	None	Relatively smaller-sized units; treatments to comply with SNFPA direction.
B	Treatments include variance from SNFPA diameter, canopy cover and disturbance-extent limits.	5.7% of adjusted land base per 10-year interval	Relatively smaller-sized units; treatments include variance from SNFPA diameter, canopy cover, and disturbance-extent limits.
C	Treatments include variance from SNFPA diameter, canopy cover and disturbance-extent limits.	11.4% of adjusted land base per 20-year interval	Relatively larger-sized units; treatments include variance from SNFPA diameter, canopy cover, and disturbance-extent limits.
Target Timing:	1 to 4 years	1 to 4 years	5 to 7 years

Source: USFS 2002

6.3 REDDING RESOURCE MANAGEMENT PLAN, 1993 (BLM)

The study area includes Redding Resource Area land managed by the BLM. BLM and National Forests lands have similar fire policies (Husari and McKelvey 1996). BLM policy states that "wildfire losses will be held at a minimum through timely and effective suppression action consistent with the values at risk." However, the Redding Field Office does not have fire suppression responsibilities for the public land it manages. Fire suppression responsibilities are provided through a Cooperative Protection Agreement authorizing CDF to protect public lands from wildland fire.

Special Management Areas (e.g., wilderness, wild and scenic rivers, areas of critical environmental concern [ACEC], natural resource areas, and archeological sites) require certain suppression restrictions to normal fire fighting tactical techniques, such as no use of tractors or heavy equipment. These areas are identified in a local Operation Plan, which was developed as a working document between State and Federal agencies to clarify which local CDF fire station is responsible for certain public land and to identify local protection boundaries. One special management area is located within CDF's Butte Unit, the Forks of Butte Creek ACEC. This area is 8 to 13 miles northeast of Chico from Portuguese Point down to Helltown, along Butte Creek, and is not in the study area.

BLM has scattered properties throughout the study area. Managing isolated properties is very difficult, especially since there are currently only two staff people assigned to address fuel load and fire issues in five counties of northern California. The *Redding Resource Management Plan* (1993) recognizes the challenge of managing isolated parcels and has identified many for transfer to an interested entity in exchange for other lands. However, BLM does try to address fuel load issues on lands that are adjacent to other agency lands and where treatments are planned. For example, the BLM is currently working with the Plumas National Forest in the Magalia and Paradise areas to create shade fuelbreaks adjacent to residences and other properties (pers. comm., Herzog, 2003).

6.4 THE CALIFORNIA FIRE PLAN, 1996 (CDF AND STATE BOARD OF FORESTRY [SBF])

In 1996, the SBF and CDF adopted a comprehensive update of the fire plan for wildland fire protection in California. The *California Fire Plan* establishes a Statewide framework to identify areas of concentrated assets and high risk, to create a more efficient fire protection system, to provide for citizen involvement, to identify prefire management needs, to encourage an integrated intergovernmental approach, and to enable policy-makers and the public to focus on effective ways to reduce future costs and losses from wildfires.

The overall goal of the *California Fire Plan* is to reduce total costs and losses from wildland fire in California by protecting assets at risk through focused prefire management prescriptions and increase initial attack success. The strategic objectives are:

- Create wildfire protection zones that reduce the risks to citizens and firefighters;
- Assess all wildlands, not just the State responsibility areas;
- Identify and analyze key policy issues and develop recommendations for changes in public policy;
- Have strong fiscal policy focus and monitor the wildland fire protection system in fiscal terms; and
- Translate the analyses into public policies.

The *California Fire Plan* applies to the project indirectly because the information within the plan is refined at the Ranger Unit level. Each unit develops a specific fire management plan that includes details broken down by battalions that are contained within the unit. The Oroville Facilities are located within Battalions Three, Five, and Six of the Butte Unit.

6.5 THE BUTTE UNIT FIRE MANAGEMENT PLAN, 2002 (CDF Butte Unit)

The *Butte Unit Fire Management Plan* documents the assessment of fire management within the Butte Unit and identifies strategic areas for prefire planning and fuel treatment to reduce destruction and costs associated with wildfire. The plan systematically assesses the existing level of wildland fire protection service, identifies high-risk and high-value areas where potential exists for costly and damaging wildfires, ranks these areas in terms of priority needs, and prescribes methods to reduce future costs and losses. The Fire Management Plan has four components: level of service, assets at risk, hazardous fuels, and historical fire weather.

To reduce the destruction and costs associated with wildfire, the Fire Management Plan aims to protect assets at risk through focused prefire management prescriptions, and in turn to improve initial attack success. The Fire Management Plan identifies five strategic objectives:

(1) **Wildfire Protection Zones** – Create wildfire protection zones that reduce the risk to citizens and firefighters.

(2) **Initial Attack Success** – Assess the initial attack fire suppression success of wildland fires on lands of similar vegetation type. This is measured in terms of percentage of fires that are successfully controlled before unacceptable costs and losses occur. The analysis can be used to determine the level of success of both the department and the unit.

(3) **Assets Protected** – Use a methodology for defining and protecting assets and determining their degree of risk from wildfire. The assets at risk addressed in the plan are life safety (citizen and firefighter), watersheds and water quality, timber, wildlife and wildlife habitat, rural communities, unique areas (scenic, cultural, and historic), recreation, range, property in the form of structures, and air quality.

(4) **Fire Management Prescriptions** – Develop fire management prescriptions that focus on alternative means of protecting assets at risk. Prescriptions may include a combination of fuel modification, ignition management, fire-wise planning and education, and predevelopment planning. Specific activities include (but are not limited to) land use planning and associated regulations, educational programs and public information, department infrastructure including fire stations and water systems, fuels management, and forest health. Prefire management prescriptions will also identify those who will benefit from such work, and consequently those who should share in the project costs.

(5) **Fiscal Framework** – Use the fiscal framework being developed by the SBF and CDF for assessing and monitoring annual and long-term changes in California's wildland fire protection systems. Incorporate prefire workload analyses in an attempt to provide relevant data to guide in the development of the fiscal framework and public policy.

The study area is primarily located within the service area of Battalion Six, although portions of the study area are also located within the service areas of Battalions Three and Five. The primary causes of fires in the study area are arson, debris burning, equipment use, and children playing with fire. Fire prevention programs and some of the objectives in Battalions Three, Five, and Six include educating the community on fire prevention, conducting fire inspections throughout the battalions, establishing local fire safety councils, reducing arson fires and illegal debris burning, improving vegetation management programs, and improving accuracy of cause determination in preliminary fire investigations.

6.6 WILDFIRE MANAGEMENT AND PLANNING: GUIDELINES AND POLICY, 2002 (DPR)

Any DPR park unit that contains vegetation that would sustain a wildland fire is required by the Departmental Operations Manual to prepare a wildfire management plan. Only half of the established park units would require a wildfire management plan, based on the vegetation composition and structure. The guidelines provide a sample outline of a wildfire management plan and details of what should be included (DPR 2002).

The guidelines suggest that a wildfire management plan be separated into three main sections: *Before the Fire*, *During the Fire*, and *After the Fire*. These sections describe the activities that are to occur during each phase of the fire. All three portions of the guidelines provide background information on how to prepare that section of the plan and the organization of department representatives. All fire fighting organizations in California operate under the Incident Command System (ICS), which is the formal administrative structure implemented to organize the complex workforce of fire fighting. During a fire, DPR's role in the ICS structure will depend on the specific conditions presented by the fire.

The guidelines suggest that the *Before the Fire* portion of the plan include any background information or preparation for fires. Specific topics suggested include wildfire potential, prefire preparation, alert levels (low, moderate, extreme), fuel management, training, fire drills, fire equipment and supplies, communications, roads, planning meetings, and a fire management compartment map.

The *During the Fire* portion should discuss fire protection priorities, fire safety, emergency evacuation plans, and modified fire suppression. Modified fire suppression includes such techniques as burnouts from natural or artificial breaks in the fuel continuity, water drops, wet lines, foam lines, and hand lines instead of dozer lines. The natural and cultural resources that DPR is mandated to protect may be at risk by some common fire suppression techniques, which disturb the soil, such as dozer lines, and may permanently destroy cultural or natural resources (DPR 2002).

The guidelines also include a section for *After the Fire,* which would cover fire history documentation, post fire resource damage mitigation, volunteer work, and pest exclusion (DPR 2002). In addition, numerous appendices are included in the guidelines, which provide specific regulations and techniques for fire protection and suppression as well as fuel load management.

6.7 LOAFER CREEK PRESCRIBED FIRE MANAGEMENT PLAN, 1999 (DPR)

The *Loafer Creek Prescribed Fire Management Plan* was prepared in 1999, prior to the DPR Guidelines established in 2002 described above. Loafer Creek Campground is located on the south side of Lake Oroville. An area description is provided that includes basic information on the physical and natural resources of the area. Quantified data are provided for precipitation, climate, and temperature. Natural resources including vegetation, wildlife, cultural, and aesthetic resources are also summarized in the area description. Recreation, fire history, and fuel characteristics are discussed.

Program objectives are defined as reducing the hazard of wildfire in developed areas while perpetuating the natural processes of plant succession in the intervening wildlands (DPR 1999). Objectives outlined in the plan include vegetation management within campgrounds that maintains visual screening, thinning on roadways and trails, and prescribed fires to reduce fuel load in the brushy understory. The DPR District Resource Ecologist is identified as the Prescribed Fire Manager, the Maintenance Supervisor is in charge of thinning and field crews, and the Burn Boss reviews and approves burn plans prepared by the Prescribed Fire Manager.

Constraints and mitigation for the effects of fire and fuel treatments are described, including: air quality and smoke management, wildlife, vegetation, cultural resources, soils, and geologically sensitive areas. Air quality is affected by burn smoke; therefore, burns are planned to occur in the late spring when allotments for generation of smoke are greater. Wildlife, such as ground dwellers and raptors, and vegetation, such as the Butte County fritillary flower, can be affected by fires. Small compartment areas are burned, leaving adjacent escape areas for wildlife. Mature plants that die back to bulbs in the summer are generally not affected by fires in late spring or early fall. Known cultural resources would be avoided by fire lines, and roads and trails would have adequate drainage structures and be designed to minimize soil erosion.

A monitoring program is outlined in the *Loafer Creek Prescribed Fire Management Plan*, which includes ongoing research to test the efficiency and effectiveness of fuel load management techniques. Fire behavior such as the type of fire, rate of spread, and other factors, would be recorded in relation to the external conditions (e.g., wind and moisture). Short- and long-term effects would be documented over time. Scorch marks and leaf browning are used for identifying short-term effects, and annual photography is used to show the change in vegetative structure over the long-term.

A burning program is defined, which identifies the Loafer Creek Subunit as the management compartment of the vegetative management plan. The Subunit is divided into several burn units and exclusion zones using existing roads and trails. The priorities of the plan are outlined, including the enhancement of safety for visitors. Prescriptions must be documented for each burn and developed by the Prescribed Fire Manager. In addition, fire line construction standards, patrols, and escaped fire suppression are described as part of the burn program.

6.8 OROVILLE WILDLIFE AREA MANAGEMENT PLAN, 1978 (DFG)

In 1968, 5,500 acres were transferred from DWR to DFG to create the OWA. In 1978, DFG developed the Oroville Wildlife Area Management Plan. The purpose of the management plan was to provide for the preservation and enhancement of the OWA and for reasonable use and enjoyment by the public. The management plan also states that destructive uses and activities incompatible with wildlife and fisheries objectives that were present at the time the management plan was written would be eliminated through enforcement of existing regulations or development of additional regulations, if necessary.

Fuel load issues were not addressed specifically in the management plan. However, fires frequently occur in the OWA, primarily due to accidents related to recreational activities such as camping, or the shooting range, or arson (pers. comm., Atkinson, 2003). OWA staff are largely involved in maintenance activities and are unable to dedicate time to wildlife habitat enhancement, vegetation restoration, or fuel load reduction projects (pers. comm., Atkinson, 2003).

6.9 CALIFORNIA PUBLIC RESOURCES CODE

The California Public Resources Code establishes regulations regarding the prevention and control of forest fires, and applies to any land covered with flammable material (Section 4291-4299). The Code states that:

Any person that owns, leases, controls, operates, or maintains any building or structure in, upon, or adjoining any mountainous area or forest-covered lands, brush-covered lands, or grass-covered lands, or any land which is covered with flammable material, shall at all times do all of the following:

- *(a) Maintain around and adjacent to such building or structure a firebreak made by removing and clearing away, for a distance of not less than 30 feet on each side thereof or to the property line, whichever is nearer, all flammable vegetation or other combustible growth. This subdivision does not apply to single specimens of trees, ornamental shrubbery, or similar plants which are used as ground cover, if they do not form a means of rapidly transmitting fire from the native growth to any building or structure.*
- *(b) Maintain around and adjacent to any such building or structure additional fire protection or firebreak made by removing all brush, flammable vegetation, or combustible growth which is located from 30 feet to 100 feet from such building or structure or to the property line, whichever is nearer, as may be required by the director if he finds that, because of extra hazardous conditions, a firebreak of only 30 feet around such building or structure is not sufficient to provide reasonable fire safety. Grass and other vegetation located more than 30 feet from such building or structure and less than 18 inches in height above the ground may be maintained where necessary to stabilize the soil and prevent erosion.*
- *(c) Remove that portion of any tree which extends within 10 feet of the outlet of any chimney or stovepipe.*
- *(d) Maintain any tree adjacent to or overhanging any building free of dead or dying wood.*
- *(e) Maintain the roof of any structure free of leaves, needles, or other dead vegetative growth.*
- *(f) Provide and maintain at all times a screen over the outlet of every chimney or stovepipe that is attached to any fireplace, stove, or other device that burns*

any solid or liquid fuel. The screen shall be constructed of nonflammable material with openings of not more than one-half inch in size.

6.10 BUTTE COUNTY

The Butte County General Plan (1996) identifies the threat of wildland fire to forests, wildlife, watersheds, and scenic resources along with the destruction of homes and other property. There may also be injury or loss of life. Secondary impacts include a reduction in the value of land and the further degradation of natural resources.

The General Plan (General Section 9) states:

> *Most of the valley fires in Butte County have been grass fires near the more populated areas of Chico, Durham, Richvale, Biggs, Gridley, and Oroville, and along the main roads connecting these communities. Although there have been fewer fires in the foothill and mountain areas than in the valley, there have been a disproportionately higher number of fires per unit of population in the foothills and mountains. This condition is probably due to the more hazardous natural combination of dense vegetation, dry weather, and steep topography which encourages rapid fire spread. (The critical factor contributing to fire spread and intensity is the density and distribution of vegetative fuel, especially brush and forests.) The number of fire incidences in the foothill and mountain area can be expected to increase along with an increase in recreational activities and residential uses. A significant hazard to life and structures from wildland fire does not exist until a wildland area is developed and occupied. Not only does the introduction of human activity into wildlands increase fire occurrences, it also increases the demand for rapid response and control of those fires.*

The General Plan also states that subdivisions, land divisions, and use permits are subject to review and approval by the County Fire Department for conformance to fire safety standards. New buildings must conform to the Uniform Building Code (UBC) requirements for fire protection systems and minimum fire resistance of materials. The county has not adopted the Uniform Fire Code, a complementary code to the UBC. The Uniform Fire Code regulates the maintenance of property and certain dangerous and hazardous activities.

Policies based on findings in the general plan relating to fire hazards are as follows:

- Make protection from fire hazards a consideration in all planning, regulatory, and capital improvement programs, with special concern for areas of high and extreme fire hazard;
- Encourage adequate fire protection services in all areas of population growth and high recreation use;
- Use fuelbreaks along the edge of developing areas in high and extreme fire hazard areas;
- Attempt to upgrade fire service where economically feasible;
- Carefully evaluate the effect of development on water supplies;

- Determine the level of water supplies necessary for fire protection purposes in new developments;
- Ensure that road access for new developments are adequate for fire protection purposes;
- Require or promote the easy identification of streets and developed properties;
- Regulate as necessary those activities and uses with a high fire potential except uses regulated by the Forest Practices Act;
- Regulate use of certain building materials in areas of higher-than-average fire hazard; and
- Require water connection to swimming pools for the purpose of fighting fires.

County Code 38A establishes specific fire prevention and protection requirements for owners and occupants of real property in the unincorporated areas of the county to create and maintain firebreaks on their property up to 30 feet wide around residences and buildings.

6.11 CITY OF OROVILLE

The City of Oroville has a city ordinance that establishes a benchmark date (June 15 of each year) for weed abatement or hazardous material reduction. This ordinance applies to vacant lots and alleys within the City boundaries and requires that the flammable vegetation be removed to mineral soil or mowed to 4 inches. Other properties must properly maintain and irrigate landscaping around structures. For large parcels (greater than 1 acre), livestock grazing is encouraged to reduce fuels. The City also works with CDF to coordinate fire prevention and safety education (such as FireWise Community programs) within the community (pers. comm., Pittman, 2003).

7.0 FUEL LOAD REDUCTION MEASURES TO CONSIDER

This section presents some general measures to consider for fuel load reduction within the study area. Additional useful data are discussed, including past fire ignitions and preliminary vegetation mapping. Measures were developed based on the review of techniques and strategies provided in Section 5 and review of the programs and policies currently used by land management agencies presented in Section 6.

7.1 FIRE IGNITIONS DATA FOR THE STUDY AREA

CDF has kept records of all known fire ignitions in Butte County, regardless of size, since 1990. The location of the ignitions are not recorded precisely but are plotted as the center of quarter sections. The estimated locations are within approximately 160 acres of the true location. Because the centers of some quarter sections occur near water bodies, as a result of the estimated mapping, it may appear that some ignitions are within water bodies.

The frequency of ignitions for each quarter section was calculated and the data classified into ranges. Figure 7.1-1 shows the frequency of ignitions in the project region. Because almost every quarter section experienced at least one ignition since 1990, the sections containing between one and six ignitions are not displayed on the figure. These data were excluded to highlight the areas with more frequent (greater than seven) ignitions. The most frequent ignitions have occurred in the urbanized areas around Oroville, Thermalito, and other communities, the Clay Pit State Vehicular Recreation Area (SVRA), and along roadways. Although not all of these areas are within the study area, fires that start in the region could potentially move into the study area.

Within the study area, the cause of fire ignitions was examined (Table 7.1-1). The most common cause of ignitions was use of equipment (24 percent), unidentified and miscellaneous causes each made up approximately 15 percent, while arson was the fourth most frequent cause of ignitions (14 percent).

7.2 VEGETATION CLASSIFICATION WITHIN THE STUDY AREA

The type of vegetation and its density contribute to the level of fuel load hazard and are important to determining appropriate reduction techniques. Although CDF's fuel hazard model considered vegetation type and other fuel variables, the analysis was conducted at a very coarse scale (450-acre blocks). Knowledge of vegetation types at a more refined scale is important in determining conditions for a specific location and identifying appropriate actions. Although this level of analysis is not within the scope of this study, data are being gathered by other work groups that may facilitate detailed analysis in the future.

Vegetation types and canopy cover classifications were mapped in the study area by DWR resource ecologists as part of the environmental studies conducted for the project (SP-T4 Biodiversity, Vegetation Communities and Wildlife Habitat Mapping). Vegetation

Table 7.1-1. Frequency and cause of fire ignitions within the study area since 1990.

Cause of Ignition	Frequency	Percent
Use of Equipment	96	24.2
Unidentified	63	15.9
Miscellaneous	61	15.4
Arson	55	13.9
Debris or garbage burning	28	7.1
Vehicle	27	6.8
Playing with fire	18	4.5
Powerline	15	3.8
Smoking	13	3.3
Lightning	8	2.0
Campfire	8	2.0
Railroad	5	1.3
Total	**397**	**100%**

Source: CDF 2002d

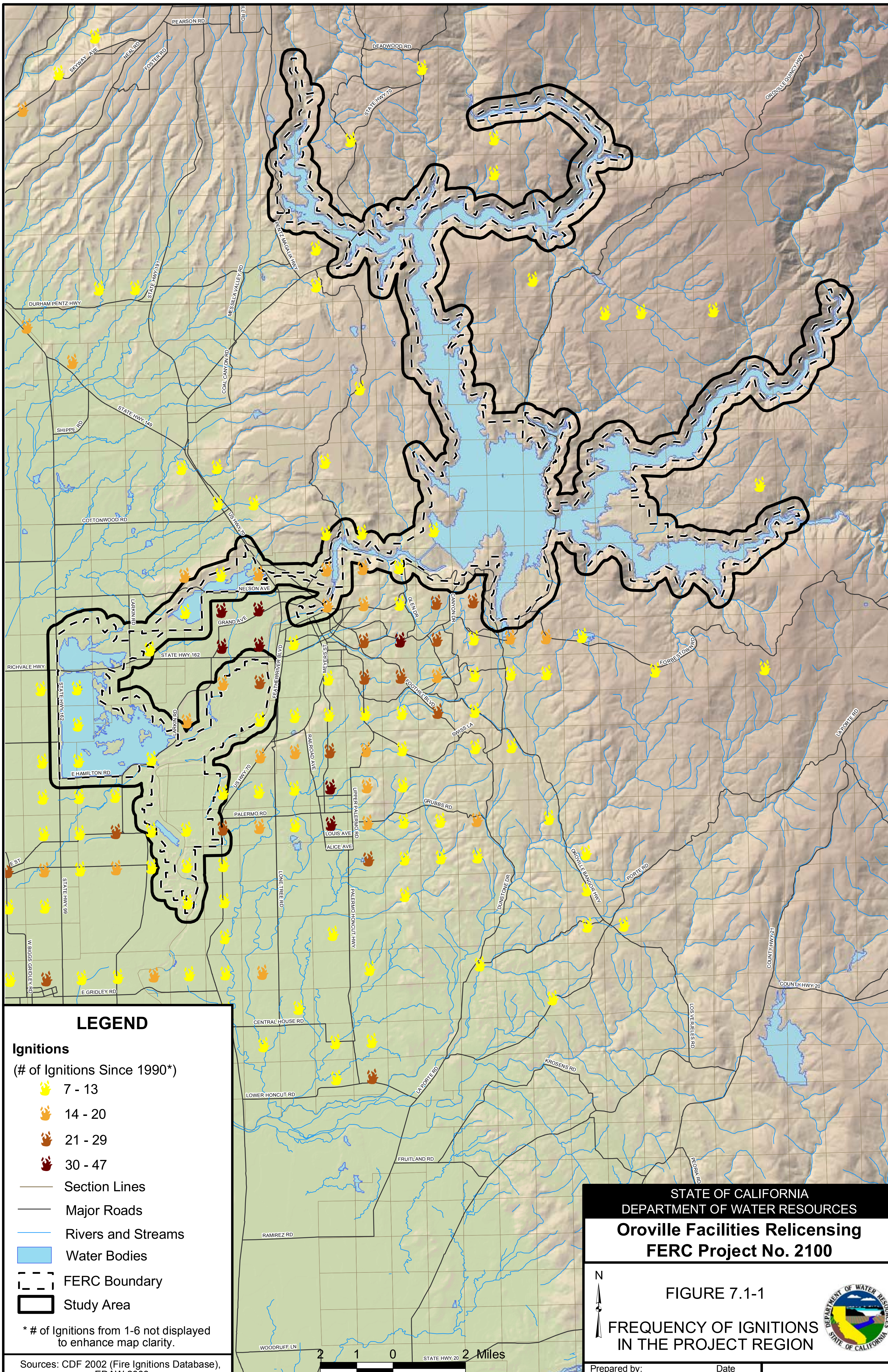
was mapped approximately 1 mile beyond the edge of the FERC boundary using aerial photos and were ground-truthed. The classification system for vegetation types and canopy cover was based on the California Wildlife Habitat Relationship system (Mayer and Laudenslayer 1988). The minimum size of polygons mapped was approximately 0.5 acre. These data should be considered preliminary; the classification system may be slightly modified as the data are analyzed (pers. comm., Kuenster, 2003).

The most abundant vegetation types are summarized in the tables below by three general areas (see Figure 4.2-3) within the study area (Tables 7.2-1 through 7.2-3). Because mapping was based on land cover, the reservoir and other water bodies are included in the total area. In general, most of the study area is characterized by woodland and shrub communities, composed of different dominant species. The canopy cover is mostly dense (60-100%), especially in the area around Lake Oroville and the diversion pool. Grasslands are most abundant in the Thermalito Forebay and Afterbay area (32% of area), but small areas (2-3%) are present in the Lake area and in the Oroville Wildlife Area.

7.3 FUEL LOAD REDUCTION MEASURES TO CONSIDER

Based on the information gathered in the previous sections on fuel load conditions in the study area, fuel load reduction techniques, and fuel load management policy and plans, some general fuel load reduction measures to consider are discussed below. These measures are not intended to be prescriptions for specific areas, but do provide a general framework for developing such projects in the future. Specific strategies for pre-fire management projects should be developed in close coordination with other agencies and the local communities (CDF 2002a). Table 7.3-1 identifies websites of organizations involved with fire management issues nationally, State-wide, and locally.

Place holder for Figure 7.1-1


LEGEND
Ignitions
(# of Ignitions Since 1990*)
7 - 13
14 - 20
21 - 29
30 - 47
Section Lines
Major Roads
Rivers and Streams
Water Bodies
FERC Boundary
Study Area
* # of Ignitions from 1-6 not displayed to enhance map clarity.
Sources: CDF 2002 (Fire Ignitions Database), EDAW 2003
N
2 1 0 2 Miles
PEARSON RD
SKYWAY AVE
NEAL RD
FOSTER RD
DEADWOOD RD
STATE HWY 70
OROVILLE QUINCY HWY
PENTZ MAGALIA HWY
STATE HWY 191
DURHAM PENTZ HWY
MESSILLA VALLEY RD
COAL CANYON RD
STATE HWY 149
SHIPPEE RD
COTTONWOOD RD
US HWY 70
NELSON AVE
GRAND AVE
LARKIN RD
STATE HWY 162
RICHVALE HWY
FEATHER RIVER BLVD
MEYERS ST
GLEN DR
CANYON DR
FORBESTOWN RD
FOOTHILL BLVD
SWISS LA
LA PORTE RD
E HAMILTON RD
RAILROAD AVE
UPPER PALERMO RD
GRUBBS RD
PALERMO RD
LOUIS AVE
ALICE AVE
OROVILLE BANGOR HWY
PORTE RD
E ST
STATE HWY 99
LONE TREE RD
PALERMO HONCUT HWY
DUNSTONE DR
COUNTY HWY 21
COUNTY HWY 20
W BIGGS GRIDLEY RD
E GRIDLEY RD
CENTRAL HOUSE RD
LOS VERJELES RD
KROSENS RD
LOWER HONCUT RD
FRUITLAND RD
PEORIA RD
RAMIREZ RD
WOODRUFF LN
STATE HWY 20
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
Oroville Facilities Relicensing
FERC Project No. 2100
FIGURE 7.1-1
FREQUENCY OF IGNITIONS
IN THE PROJECT REGION
DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA
Prepared by:
EDAW (LC)
Date
6-30-03
X 7.1-1.mxd

BACK OF FIGURE 7.1-1

Table 7.2-1. Major vegetation types and canopy cover for the Lake Oroville and Diversion Pool portion of the study area.

Land Cover Type	Canopy Cover	Acres	Percent of Total Area
Lake Oroville	--	15,475	32%
Mixed pine-mixed oak woodland-chaparral	60-100	3,605	7%
Mixed oak woodland	60-100%	3,151	6%
Mixed oak woodland-chaparral	60-100%	2,667	5%
Foothill pine-mixed oak woodland-chaparral	60-100%	2,641	5%
Ponderosa pine-mixed oak woodland	60-100%	2,533	5%
Foothill pine-mixed oak woodland	60-100%	1,735	4%
Mixed conifer hardwood forest	60-100%	1,369	3%
Canyon live oak woodland	60-100%	1,298	3%
Ponderosa pine-mixed oak woodland-chaparral	60-100%	1,235	3%
California annual grassland	--	951	2%
Mixed pine-mixed oak woodland	60-100%	821	2%
Other types each contribute 1% or less to total	varies	11,327	23%
Total	**varies**	**48,808**	**100%**

Source: DWR 2003

Table 7.2-2. Major vegetation types and canopy cover for Thermalito Forebay and Afterbay portion of the study area.

Land Cover Type	Canopy Cover	Acres	Percent of Total Area
California annual grassland	--	4,069	32%
Lake Oroville	--	3,680	29%
Urban/disturbed	--	849	7%
Agriculture/rice	--	829	7%
Disturbed grassland	--	675	5%
Urban/residential	--	489	4%
Rush	40-59%	356	3%
Urban/rural ranch	--	207	2%
Rush/verbena	60-100%	201	2%
Other types each contribute 1% or less to total	varies	1,393	9%
Total	**varies**	**12,748**	**100%**

Source: DWR 2003

Table 7.2-3. Major vegetation types and canopy cover for the Oroville Wildlife Area portion of the study area.

Land Cover Type	Canopy Cover	Acres	Percent of Total Area
Deciduous orchard	--	869	10%
Cottonwood riparian forest	40-59%	842	9%
Gravel tailings	--	792	9%
Cottonwood riparian forest	60-100%	760	8%
Cottonwood riparian forest	25-39%	735	8%
Disturbed/barren	--	528	6%
Water primrose	--	415	5%
Riverine	--	407	4%
Pond	--	374	4%
Urban/disturbed	--	317	4%
Disturbed grassland	--	285	3%
California annual grassland	--	280	3%
Valley mixed riparian forest	60-100%	251	3%
Urban/residential	--	249	3%
Cottonwood riparian forest	10-24%	222	2%
Valley mixed riparian forest	40-59%	167	2%
Valley mixed riparian forest	25-39%	157	2%
Other types each contribute 1% or less to total	varies	1,328	15%
Total	**varies**	**8,978**	**100%**

Source: DWR 2003

Table 7.3-1. Fire management organizations and websites.

Organization	Program	Website
Fire Safe Council	National	http://www.firesafecouncil.org/
Butte County Fire Safe Council	Local	http://www.firesafecouncil.org/
Oroville Community Association	Local	http://www.firesafecouncil.org/
CDF and SBF	Statewide	http://www.fire.ca.gov/FireEmergencyResponse/FirePlan/FirePlan.asp
CDF	Statewide Resource Management Program	http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp
CDF	Statewide Fire and Resource Assessment Program	http://frap.cdf.ca.gov/
California Fire Alliance	Statewide Inter-agency coordination	http://www.cafirealliance.org/default.php
National Fire Plan	National	http://www.fireplan.gov/
USFS	National Fire and Aviation Management	http://www.fs.fed.us/fire/
BLM	National Office of Fire and Aviation	http://www.fire.blm.gov/

Source: Compiled by EDAW 2003

Because of the high value of life and property and potential for high fuel loading, the interfaces between wildlands and urban areas are considered to be at significant risk of loss due to fire (SNEP 1996). The interface zone around communities can be protected by creating fuelbreaks such as CDZs, or shaded fuelbreaks. In addition, community members in many areas are being educated about fire danger and preventative measures. Some communities in the study area, such as Butte County and the Oroville Community Association, have established Fire Safe Councils. The mission of Fire Safe Councils is to use the combined expertise, resources, and distribution channels of its members to preserve California's natural and man-made resources by mobilizing all Californians to make their homes, neighborhoods, and communities fire safe (Fire Safe Council Website). Community members are encouraged to create defensible space around their homes and follow fire safety guidelines for inside and outside of homes. Information regarding how to create fire safe communities is readily available on the internet through the Fire Safe Council and CDF websites listed below. Properties in the wildland-urban interface also should be inspected for hazardous fuel conditions to ensure compliance with city, county, and State ordinances.

In other wooded areas, fuelbreaks or DFPZs can be created to reduce the chance of fire spreading and provide safe areas for fire suppression efforts. Fuels could be reduced in target areas by using techniques that are appropriate to the site. Preferred methods generally are mastication and thinning from below, as these methods tend to be less environmentally damaging and are fairly cost-efficient in comparison to other methods (Table 5.1-1). However, other techniques may be recommended for specific areas. Once fuels have been reduced, prescribed burns could be used, where feasible, to restore ecological processes.

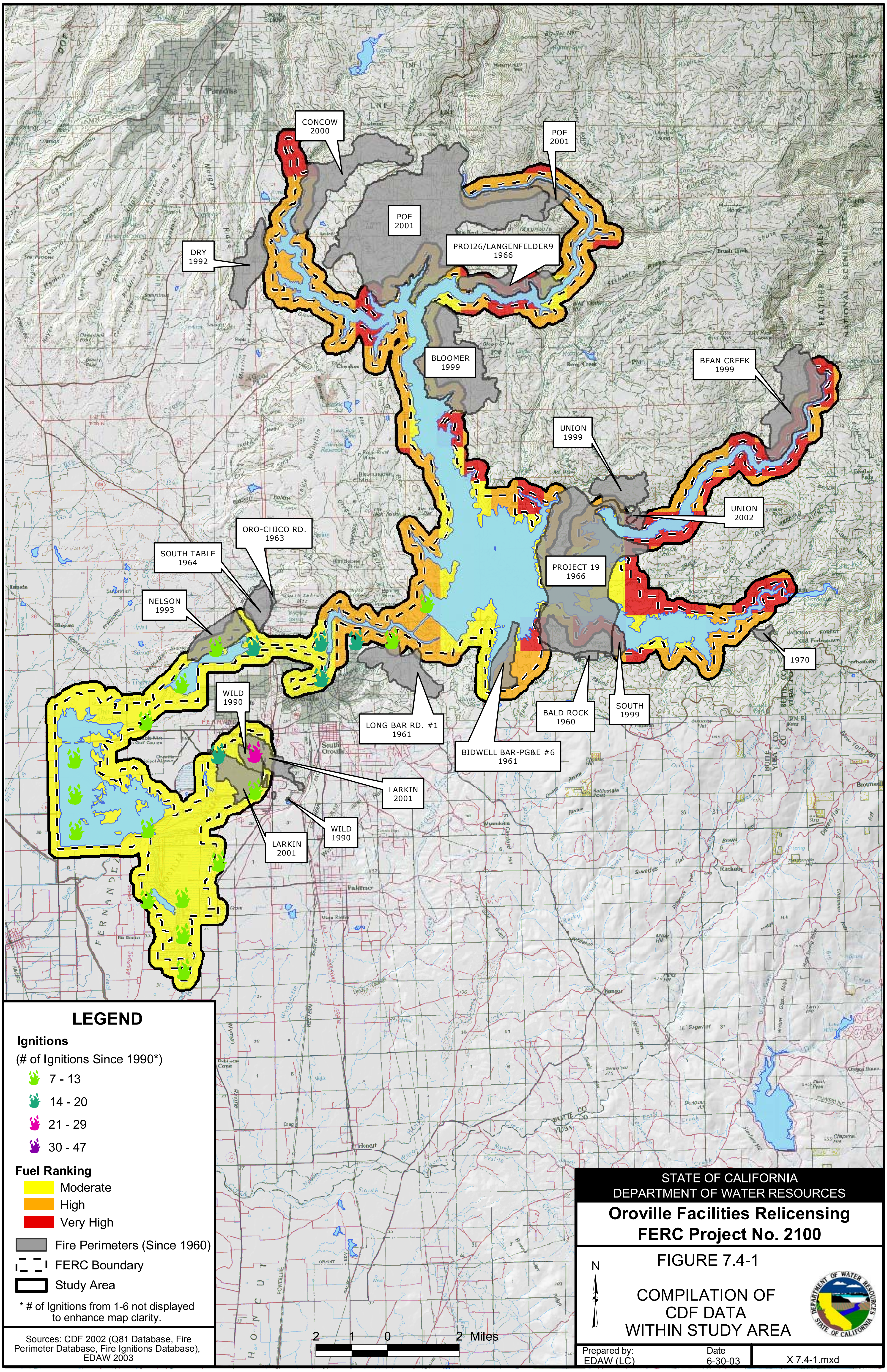
In grassland areas, prescribed burns could be used where feasible to control weeds, to promote nutrient cycling, and to encourage growth of native species (especially in vernal pool ecosystems). If burning is not feasible, fuels could be reduced by mowing or disking. Grazing in selected areas may be a useful technique to reduce fuel load, if it is compatible with other land use policies and goals in the area.

In riparian areas, prescribed burns conducted in the early spring can be an effective method to reduce ground fuels and promote germination of herbaceous species, thus enhancing wildlife habitat (pers. comm., Atkinson, 2003). Burning in the spring, when fuels are not as dry as later in the year, allows the fire to maintain cooler temperatures and protects riparian trees from scorching. Spring burning is generally conducted early in the season, before most birds initiate nesting activities.

7.4 COMPILATION OF CDF DATA

CDF's fire ignitions data, fire history data, and fuel hazard rankings within the study area are displayed together in Figure 7.4-1. Only fires since 1960 (the approximate start of the Oroville Facilities' operation) are included. This map could be used to identify general areas that may warrant more detailed evaluation in the future. For example, an area where there is a high frequency of ignition, that is within an area of very high fuel hazard, and that has not burned recently may be considered a priority for developing a fuel reduction project. Identifying specific areas for fuel treatment is not part of the objectives of this study but would be part of developing a fire management plan.

Place holder for Figure 7.4-1



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

FIGURE 7.4-1

COMPILATION OF
CDF DATA
WITHIN STUDY AREA

Prepared by: EDAW (LC)	Date 6-30-03	X 7.4-1.mxd

Back of Figure 7.4-1

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